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PENSOFT

Range extension and natural history comments of periurban populations of *Sphaenorhynchus caramaschii* Toledo, Garcia, Lingnau & Haddad, 2007 (Anura, Hylidae) in the state of São Paulo, Brazil

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Abstract

The present study records the occurrence of *Sphaenorhynchus caramaschii* Toledo, Garcia, Lingnau & Haddad, 2007 for periurban areas of São Paulo and Sorocaba cities, eastern side of São Paulo state. These new records represent the northeastern known localities for this species and expand the septentrional limit of its geographic distribution. We also present comments and biological information for these recently discovered populations.

Key words

Amphibia; Neotropical treefrog; Atlantic Forest; São Paulo; range expansion.

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Introduction

Recent studies have discovered new species of *Sphaenorhynchus* genus (Toledo et al. 2007, Caramaschi et al. 2009, Araujo-Vieira et al. 2015, Roberto et al. 2017), which currently consists of 15 species of small greenish tree frogs (Frost 2018). These species inhabit permanent and temporary ponds in open areas and forest edges, with floating vegetation or partially submerged in the water (e.g., Lutz and Lutz 1938, Bokermann 1973, Cruz and Peixoto 1980).

Most species of *Sphaenorhynchus* are widespread throughout in the Brazilian Atlantic Forest, from the state of Pernambuco to Rio Grande do Sul (e.g. Cochran 1953, Bokermann 1973, Caramaschi et al. 2009, Araujo-Vieira et al. 2015, Roberto et al. 2017), but only *S. platycephalus* (Werner, 1894) (see Araujo-Vieira et al. 2018) and *S. caramaschii* have been recorded in the state of São Paulo

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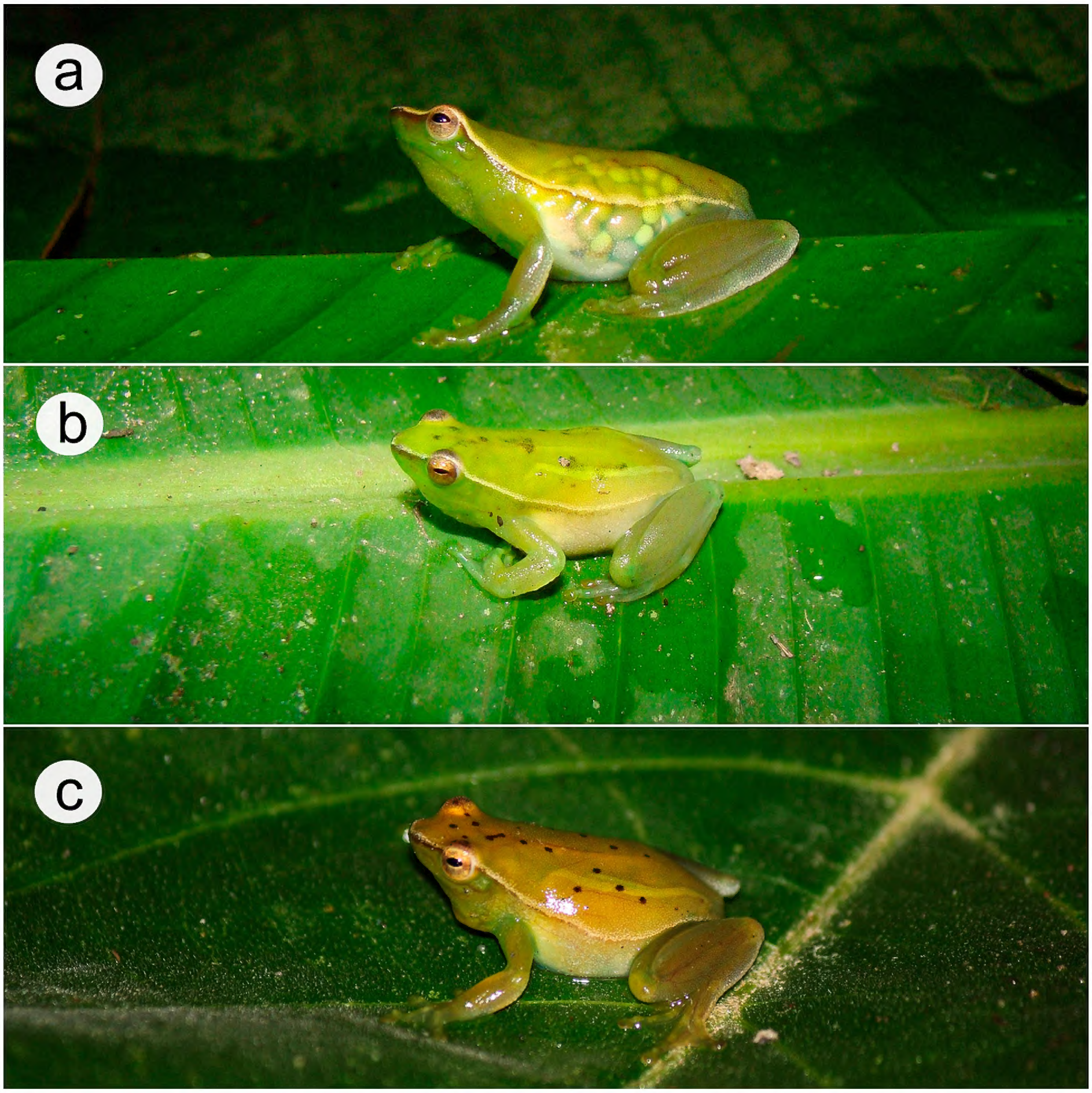

Figure 1. Live specimens photographed: **a**) female with visible eggs in Parque Natural Municipal Cratera Colonia, São Paulo, SP; **b**) male in Fazenda Castanheiras, São Paulo, SP (ZUEC-AMP 18211); and **c**) male in the district of Marmeleiro, Mairinque, SP.

(Rossa-Feres et al. 2011).

Sphaenorhynchus caramaschii Toledo, Lingnau, Garcia & Haddad, 2007 is a medium-sized species within the genus (snout-vent length: 23.25–25.94 mm in males and 26.45–28.89 mm in females). This species presents a lengthy advertisement call (Toledo et al. 2007), which contains a long note with evident pulses and a short note with one pulse (Forti et al. 2017). During rainy season, males vocalize mainly perched on the emergent plants at ponds in open areas and forest edges (Toledo et al. 2007, Almeida et al. 2008, Forti et al. 2017). The eggs are attached individually to submerged vegetation. *Sphaenorhynchus caramaschii* occurs at the highlands of the states of Santa Catarina, Paraná and São Paulo, Brazil (Toledo et al. 2007). In the state of São Paulo, this species is distributed in the southern and central portions, noticeably in the municipalities of Botucatu and Pilar do Sul, that represent, respectively, north and northeastern limits of its geographical distribution (Toledo et al. 2007, Almeida et al. 2008). The present study shows new records of *S. caramaschii* and expands the northeastern limit of its geographic distribution and also presents comments on the natural history of these populations.

Methods

Between the years 2011 and 2013, individuals of *Sphaenorhynchus caramaschii* were recorded in various sites in the state of São Paulo, Brazil (see Table 1 for sources including the present study). The calls of the males were recorded using a digital recorder (Marantz PMD 660) and an external directional microphone (Seinheiser ME 66) and photographed with a digital camera (Sony DSC-H9). Advertisement calls were deposited

Table 1. Records of *Sphaenorhynchus caramaschii* in the state of São Paulo.

Site	Municipality	Latitude (S)	Longitude (W)	Altitude (m)	Source
Parque Natural Municipal Cratera do Colônia	São Paulo	23°52′54″	046°42′37″	760	Present study
Fazenda Castanheiras	São Paulo	23°49′22″	046°38′53″	750	Present study
Parque da Várzea do Embu-Mirim	Embu das Artes	23°39′48″	046°49′31″	770	Present study
Marmeleiro	Mairinque	23°32′15″	047°09′47″	820	Present study
Floresta Nacional de Ipanema	Iperó	23°25′49″	047°38′03″	700	Present study
Not available	Tapiraí	23°55′06″	047°28′07″	870	Condez et al. 2009
Rio do Peixe	Ibiuna	23°52′53″	047°21′29″	860	Araujo et al. 2013
Not available	Pilar do Sul	23°48′46″	047°43′27″	700	Toledo et al. 2007
Parque Estadual Estância Turistica do Alto do Ribeira	Iporanga	24°25′01″	048°29′59″	270	Toledo et al. 2007
Not available	Apiaí	24°30′40″	048°50′47″	260	Toledo et al. 2007
Fazenda Intermontes	Ribeirão Grande	24°11′45″	048°25′29″	950	Toledo et al. 2007
Fazenda São Luis	Ribeirão Branco*	24º21′30″	048º44′35″	910	Toledo et al. 2007
Fazenda Intermontes	Ribeirão Grande	24°11′58″	048°26′08″	905	Araujo-Vieira et al. 2015
Estação Ecológica Angatuba	Guareí	23°26′04″	048°19′53″	740	Araujo & Santos-Almeida 2013
Estação Ecológica Angatuba	Guareí	23°25′16″	048°19′10″	720	Araujo & Santos-Almeida 2013
Estação Ecológica Angatuba	Angatuba	23°25′40″	048°21′25″	645	Araujo & Santos-Almeida 2013
Not available	Avaré	22°51′09″	048°50′11″	600	Almeida et al. 2008
Rubião Junior	Botucatu	22°51′55″	048°32′59″	835	Almeida et al. 2008
Rubião Junior	Botucatu	22°59′36″	048°29′31″	824	Almeida et al. 2008
Fazenda Rio Claro	Lençóis Paulista	22°46′55″	048°50′46″	610	Almeida et al. 2008

*Type Locality.

in the Fonoteca Neotropical Jacques Vielliard (FNJV), Universidade Estadual de Campinas (UNICAMP). Specimens were euthanized via anesthetic overdose (5% lidocaine), fixed in 10% formalin, and preserved in 70% ethyl alcohol. We collected (collection permit #14/2012 Proc. SMA/CFS 8.431/2011) 2 males in the municipality of Embu das Artes and the amphibians were deposited in the Museu de Zoologia da Universidade de São Paulo (MZUSP), and another specimen was collected in the municipality of São Paulo and deposited in the Museu de História Natural (ZUEC), UNICAMP.

Results

New records. Brazil: São Paulo. Municipality of São Paulo. Near the Parque Natural Municipal da Cratera de Colônia, PNMCC (23°52′54″ S, 046°42′37″ W, WGS84 datum, 760 m elev.), Marcos A. Melo and Kleber E. Rodrigues observers/collectors, 9 October 2011 (1 female with visible eggs, photographed, Fig. 1a, not collected; advertisement calls from 1 male, FNJV 12045 and the specimen collected, ZUEC-AMP 18211. Municipality of São Paulo: Fazenda Castanheiras, in the Environmental Protection Area (EPA) Bororé-Colônia, in a branch of the Billings reservoir (23°49′22″ S, 046°38′53″ W, WGS84 datum, 750 m elev.), Marcos A. Melo and Kleber E. Rodrigues observers, 18 September 2011 (1 adult male photographed, Fig. 1b, not collected). Municipality of Embu das Artes: Parque da Várzea do Embu-Mirim, in a permanent pond (23°39′48″ S, 046°49′31″ W, 770 m elev.), Renato A. Martins and Sostenes J. S. Pelegrini collectors, March and August 2012 (2 specimens, MZUSP 150397 and MZUSP 150398). Municipality of Mairinque: Marmeleiro (23°32′15″ S, 047°09′47″ W, 820 m elev.), Sostenes J. S. Pelegrini and Marcos A. Melo observers, 29 August 2013 (1 specimen, photographed, Fig. 1c). Municipality of Iperó: Floresta Nacional de Ipanema, in a permanent pond (23°25′49″ S, 047°38′03″ W, 700 m elev.), Kleber E. Rodrigues recorder, 4 November 2012 (advertisement calls, FNJV0037786).

Identification. Specimens were found to be in agreement with the description in Toledo et al. (2007), following the feature combination that distinguishes *Sphaenorhynchus caramaschii* from others species within the genus, such as 1) absence of external tympanum, 2) presence of a dark line from the snout to the eyes, and especially 3) by the long and remarkable advertisement call (Toledo et al.2007, Forti et al. 2017). This species is morphologically similar to *S. surdus* and distinguished by its snout generally truncated; its head can be slightly mucronated and, its advertisement call is especially long (Toledo et al. 2007). This advertisement call can last 11.5 seconds and can reach 1–43 notes, which can be long multipulsed and/or short single pulse (Forti et al. 2017). This identification was confirmed by Prof. Dr Felipe Toledo, one of the researchers that described the species (Toledo et al. 2007).

Discussion

The distribution of *Sphaenorhynchus caramaschii* had little changes since the last range expansion (Almeida et al. 2008). Some new records were added, but they are among expected localities and same hydrographical basin. For example, records of this species in Tapiraí (Condez et al. 2009) and between Ibiúna/Piedade (Araujo et al. 2013) are 31 and 36 km distant from Pilar do Sul

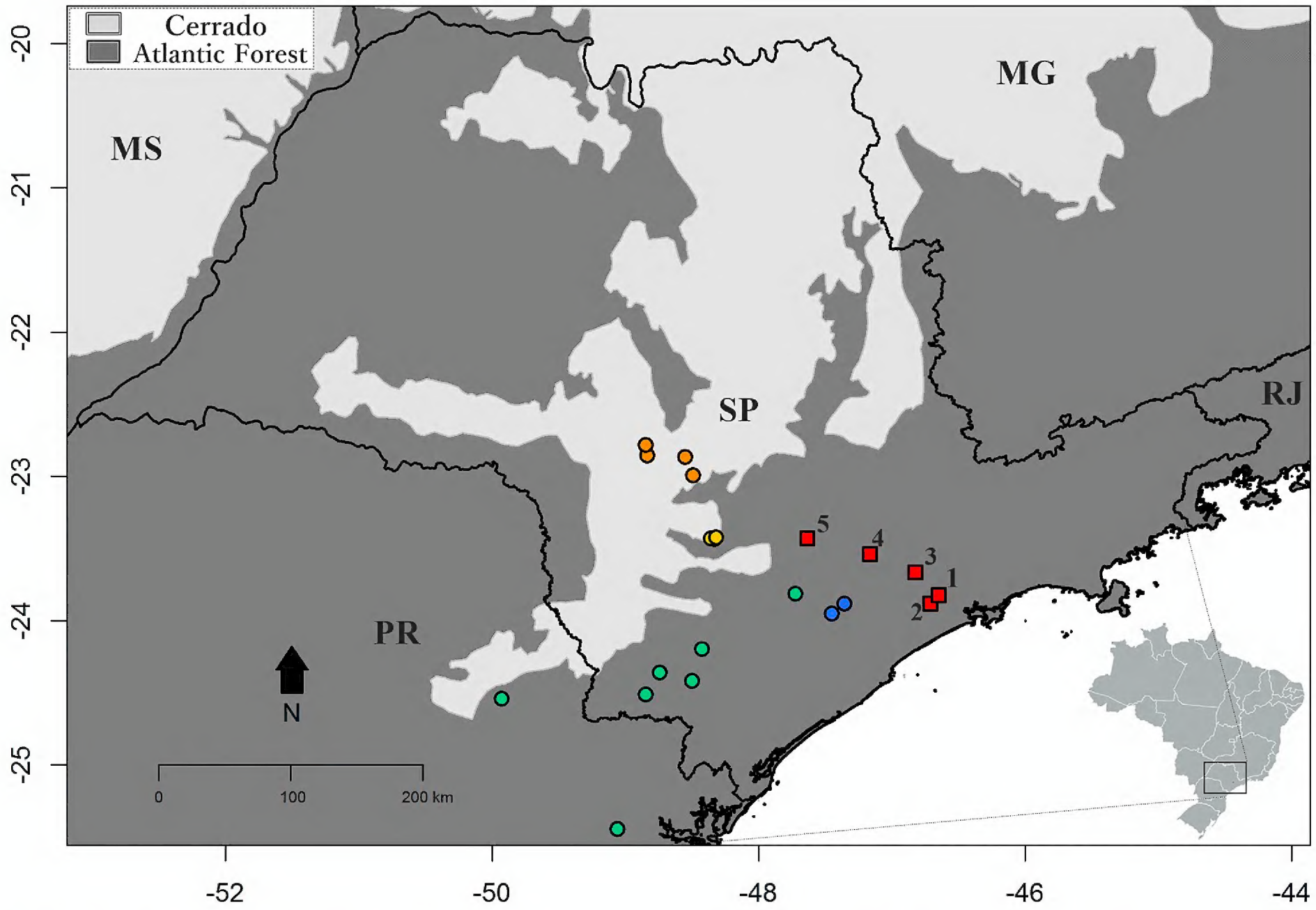

Figure 2. Distribution map of *Sphaenorhynchus caramaschii*. Previous records in the last review by Almeida et al. (2008): green circles (Toledo et al. 2007), orange circles (Almeida et al. 2008); Update review: yellow circles (Araujo and Santos-Almeida 2013), blue circles (Condez et al. 2009, Araujo et al. 2013); This study: red squares: new records in the municipalities of São Paulo[1–2], Embu das Artes[3], Mairinque[4] and Iperó[5].

(Toledo et al. 2007), respectively; records in Angatuba and Guareí (Araujo and Almeida-Santos 2013) are 60 and 65 km from Botucatu (Almeida et al. 2008), respectively. These records were expected because they were among the municipalities of Pilar do Sul and Botucatu and they do not provide substantial changes of the species distribution limits.

Herein, we present 5 new records of *S. caramaschii* in the state of São Paulo, Brazil (Fig. 2). Our first records from municipality of São Paulo extend the geographic distribution of *S. caramaschii* in Alto Tietê basin and extending the range by approximately 70 km on the northeastern side from Piedade/Ibiúna (Araujo et al. 2013), and 200 km east from Botucatu (Almeida et al. 2008). Moreover, we present the first records of this species in municipalities of Embu das Artes, Mairinque, and Iperó, filling the gap among the previous studies (Toledo et al. 2007, Almeida et al. 2008) and municipality of São Paulo (Fig. 2).

The vegetal formation in the new localities is composed by Dense Ombrophilous Forest, except in Iperó that presents Seasonal Semidecidual Forest. In the Brazilian Savanna (Cerrado) of the state of São Paulo, the species has already been recorded in Seasonal Semidecidual Forest (Almeida et al. 2008), representing the unique records outside Atlantic Forest. All permanent ponds presented riparian forest in initial stage of regeneration and abundant floating macrophytes (*Salvinia* sp.). In Parque Natural Municipal da Cratera de Colônia (PNMCC), most of the males (n =12) were calling on the floating macrophytes, while only 1 specimen was perched on marginal vegetation (*Hedychium* sp.), confirming the kinds of calling sites described by Toledo et al. (2007). Almeida et al. (2008) suggest that *S. caramaschii* inhabits permanent ponds near the forests. Our observations support this suggestion, although riparian vegetation of Fazenda Castanheiras (FC) is represented mostly by exotic plants *Pinnus*, *Cunninghamia* and *Eucalyptus*.

On these localities, alien species of fish *Cyprinus carpio* Linnaeus, 1758, *Oreochromis niloticus* (Linnaeus, 1758) and *Tilapia* sp. (Mattox 2008), American Bullfrog *Lithobathes catesbeianus* (Shaw, 1802) (Malagoli 2008), and Crawfish *Procambarus clarkii* (Girard, 1852) (pers. obs.) embody the local fauna, especially in FC, at the margin of the Billings reservoir. These species are acknowledged as predators of Brazilian anurans in different stages of life and may negatively impact its populations (Leivas et al. 2012, Banci et al. 2013). Besides, these new records are next (mean = 4.6 km, min = 0.1, max. = 16, n = 5) to the fringe of metropolitan areas (São Paulo and Sorocaba). The expansion of urban areas over natural habitats has caused the dramatical impoverishment of the high diversity of Atlantic Forest anuran assemblages (Lourenço-de-Moraes et al. 2018). Although *S. caramaschii* populations present

the ability of adjustment to landscape changes (Toledo et al. 2007), the reason of its persistence in the urban landscape is not clear and needs long-term monitoring.

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Authors' Contributions

MAM and RAM wrote the manuscript with support from SJSP and KER. All authors collected data and identified the specimens, as well as discussed the results and contributed to the final manuscript.

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